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BIOLOGY AND MANAGEMENT OF WALNUT HUSK FLY (RHAGOLETIS COMPLETA) IN WALNUTS

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Project status in 2024: Year 3 of 3

PROJECT OBJECTIVES:

Evaluate the efficacies of entomopathogens for the biological control of walnut husk fly.

BACKGROUND

Walnut husk fly (WHF), Rhagoletis completa, is the most challenging pest for walnut growers to manage. The flies emerge during the summer, and within two weeks, females lay eggs in the husk underneath the fruit skin. The larvae (i.e., maggots) feed on the husk, which results in shriveling and darkening of the kernels or shell staining and eventually impacts the quality and yield. The current WHF control method entirely relies on insecticide spray multiple times during the summer, and this approach is not sustainable. Exploring better solutions to control walnut husk flies has been ranked the highest research priority identified by the California Walnut Board's Entomology workgroup through priority-setting meetings in recent years. Therefore, we proposed a research project aimed at exploring potential alternatives by using soil-inhabitant biological control agents, particularly entomopathogenic nematodes (EPNs) and entomopathogenic fungi (EPFs), to aid reducing husk fly populations in walnut orchards. Previous studies involving entomopathogens against multiple fly pests such as western cherry fruit fly, olive fruit fly, and even walnut husk fly in different geographic regions and states have yielded positive results.

METHODS & KEY FINDINGS

- Between the 2021 and 2023 seasons, we conducted several laboratory and small- and big-plot field trials to evaluate the efficacy of the EPF Beauveria bassiana and three species of EPNs—Heterorhabditis bacteriophora (HB), Steinernema feltiae (SF), and Steinernema carpocapsae (SC)—in different combinations. Those studies showed that entomopathogenic nematodes, Heterorhabditis bacteriophora (HB) and Steinernema feltiae (SF), caused higher mortality of WHF larvae compared to the control and EPF treatment in the laboratory and small-plot field trials, and these entomopathogens persist at least 4 weeks capable of

continuing infecting the live insect. These studies (reported in 2023-Walnut Research Report) confirmed that these entomopathogens have the potential to be effective in the field against walnut husk flies and can kill the host larvae for a few weeks after field application.

- For the field study, we initiated a trial in Fall 2022 to test the efficacy of EPF and EPNs utilizing bigger field plots (~1.5 acres) with three replications against walnut husk fly in a commercial orchard in Stanislaus County. A tractor-driven weed sprayer was used to deliver entomopathogens to the soil surface between tree rows at 33 gallons/acre of water volume for all applications. The orchard floor was mowed before applying the treatments, and the field was irrigated for about 3 hours before and 24 hours after the treatment application to keep it moist. Seven WHF yellow sticky traps with lures ammonium carbonate lures were installed in each plot center, and trap counts were recorded. The results at the end of the 2023 season showed that two field applications of EPNs-Combo and EPF, reduced the husk fly emergence by 29% and 22.6%, respectively, compared to untreated control treatment.
- As a multiyear application strategy, in 2024, two applications of EPF Bueaveria bassiana and EPN Steinernema feltiae were made on those plots, two months apart in the summer. Ten WHF traps were installed in each plot, and the trap captures 3-4 weeks after each application was recorded. The trap data from each plot were highly variable, and no statistical differences were observed among treatments. In addition, we collected walnut samples (6 samples per treatment, 40 nuts/sample) from each plot at harvest and evaluated for husk feeding damage. Walnut husk fly damage to husks was the lowest in nematode-treated plots (8.33%). However, it was not statistically different than other treatments – EPF (17.5%) and Untreated Control (18.33%).

  Studies from the laboratory and small-plot trials we conducted in previous years showed a clear efficacy of entomopathogens against the walnut husk fly. However, the field efficacies have been variable based on the evaluation criteria, especially the trap counts. Walnut husk fly trap effectively detects the occurrence of flies in the orchard, but it might not be the best tool for estimating the population. In contrast, walnut husk damage at harvest was almost half the nematode-treated compared to the Untreated Control plot. This discrepancy between evaluation methods might be due to the low efficiency of the trap. It could be that the environment affected the efficacy in some years. Since these organisms are susceptible to hot and dry environmental conditions, a more heat-tolerant species and/or slow-release formulation (e.g., capsule) might be needed for further testing. It is also important to look at the effects of cover crops and ground vegetation on walnut husk fly emergence and the persistence of entomopathogens.

Figure. Average WHF feeding damage on walnut husks across three treatments. No statistical difference in emergence rates across treatments at a 5% significance level ($P = 0.072$).